XIV. *An Enquiry into the original State and Properties of* Spar, *and* Sparry Productions, *particularly, the* Spars, *or* Cryſtals *found in the* Corniſh *Mines, called* Corniſh Diamonds. *In a Letter to* Emanuel Mendez da Coſta, *Eſq; F. R. S. from the Rev. Mr.* Wm. Borlace.

S I R,

Read Dec. 14, 1749. May 3, 1750.

SINCE among your Searches into Natural Hiſtory, you think it worth your while to be particularly inquiſitive after our cryſtallized Spars, commonly called *Corniſh Diamonds*; I will give you the beſt Information I can concerning them, aſſuring myſelf, that you will make proper Allowances for the want of ſuch Aſſiſtances as are not to be had in my preſent Situation.

I ſhall conſider Spar here as the Genus, at the Head not only of all the Species of common Spar, and Incruſtations of what Colour ſoever, but of Cryſtals and Gems, which are here underſtood only as finer and purer Subſtances of the Spar Kind (1).

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(1) The Properties of Cryſtal aſſigned by a late Treatiſe (*Mr. Hill's Nat. Hiſt. of Foſſils*), ſuch as keeping itſelf unaffected by Acid Menſtrua, remaining unaltered in a moderate Fire, and giving forth Sparks of Fire by Colliſion (whereby that Author diſtinguiſhes it from Spar), are here reckoned, rather to be accidental and claſſical Differences, owing to a purer ſtony Juice, leſs friable and

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There are ſeveral Sorts of theſe ſparry Productions, which are carefully to be diſtinguiſh'd from each other; but they may all be conſidered, firſt, with regard to their original State, or what they have been; and, in the next Place, as to what they now are, that is, as to Form, Size, Colour, Hardneſs, Texture of Parts, and Direction of their Shoots in the Mines or Quarries. Theſe Particulars, ſeparately diſcuſſed, may poſſibly lead us to ſeveral probable Conjectures concerning the Original and moſt diſtinguiſhing Properties of theſe Bodies, ſuch as may afford ſome Light to this perplexed and intricate Subject.

SECT. I.

That all Spar has been, at one time or other, in a State of Fluidity, may be maintained, I think, with great Reaſon, as well as ſupported by the Authority of ſome of the moſt eminent Naturaliſts (2). In ſome Spars are found Straws, and other light Bodies; and we may therefore as juſtly conclude them to have been once fluid, as the Amber that incloſes the Bee. In ſome Stones, whereon were ſparry Concretions,

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and terrene than that of the common Spar, than to any eſſential and radical Difference in the Principia of theſe Bodies. [" There is in " all Spar more or leſs of Cryſtal." *Woodward's Nat. Hiſt. Foſſils*, 158.] For many Spars there are, which are opaque, and yet in the ſame hexagonal Form as Cryſtals; whence it appears, that Spar and Cryſtal do not differ in Subſtance and Nature, but in Tranſparency, Colour, and different Degrees of Purity. " Spars much the ſame with Cryſ-" tals, ſays Dr. *Plot*, *Oxf. p.* 98. §. 52." And *Boetius* doubts not, but they (*viz.* Spars) are of the ſame Matter with Gems, *ib.* §. 53.

(2) *Woodward's* Catal. of Foſſ. Vol. 1. p. 151, and 157. No. 78. *alibique paſſim.*

Dr. *Woodward* found Fragments of Shells, and Pellicles of the Ova of Fiſhes; a certain Evidence, that this ſparry Production was not anterior to the Deluge; for the Stone muſt have coaleſced and hardened upon the Shell, before the ſparry Concretion could have fixed upon the Surface of the Stone; and as I apprehend, the Learned are now very well ſatisfy'd, that ſuch extraneous Foſſils as are mentioned above, are not the *Luſus Naturæ*; but the Exuviæ of Animals brought where we find them by the Waters of the Deluge.—Where-ever any Number of the ſhotten Spars occur, there may be ſeen ſucceſſive Incruſtations and Cryſtals fixing on other Cryſtals, ſome Incruſtations broken off, and ſhewing their concave Baſe, ſhaped by the Cuſpis or Apex of the Diamonds on which they were once faſtened; which ſhews, that there has been a Succeſſion of ſeparate and diſtinct Indurations. —— In ſeveral Places we find wavy Proceſſes * formed in thin Plates, on the perpendicular Sides of the Rocks, by the Spars flowing down in the ſame Manner, as one Wave ſucceeds another on the Sea-Shore; to which we may add, the frequent Formation of ſparry Efloreſcencies, Accretions on Walls, and Stalactites hanging down from the Vaults and Caverns of deſerted Mines, Evidences ſufficient of the modern Date of ſuch Productions. That we may the eaſier apprehend this Truth of Spars having been once a Fluid (upon which much depends), it may here be obſerved, that ſomething very like this Proceſs, (I mean Liquors hardening into Stone) is commonly ſeen in the Effects of petrifying Waters; where as ſoon as the ſtony Juice meets a proper Nidus of Wood, Reed, Graſs, or the like, it will forſake its State of Fluidity, and become a ſolid Stone: Why then ſhould it ſeem more unaccountable or difficult, to conceive that the ſame Alteration ſhould happen in the Bowels of the Earth, and in larger Maſſes of Matter? For as the ſame Cauſe will in like and equal Circumſtances produce the ſame Effect, ſo to produce a greater Effect (*viz.* an Alteration of Form or Motion in a greater Quantity of Materials), there is need only of a proportionably greater Force in the Cauſe; it being as eaſy for a powerful Effort to produce a Rock, or a Mountain, as for a ſmaller Force to congeal a Pebble, or form the ſmalleſt Gem. If it were poſſible, therefore, for us to be as attentive Witneſſes of the Changes which happen under the Surface, as we are of thoſe which appear on the Banks of every petrifying Spring, we ſhould diſcover many new Stones produced every now-and-then, which by their Firmneſs appear now to have been as old as the World (3). It is indeed a vulgar Miſtake to imagine, that Time has added, or ſhall add, to the Firmneſs of a Spar; or becauſe it is ſo hard and compact a Body, that it cannot therefore but be as old as the firſt Formation of Things; for Spar becomes as hard at the firſt Time of its conſolidating, as it will be ever after, as we find by the exact

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* See *Tab.* V. *Fig.* 22.

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(3) Since the Writing of the following Treatiſe, Mr. *Hill* (*Nat. Hiſt. of Foſſils, p.* 157.), by a curious chemical Inveſtigation of the lapideous Contents of Water, ſays, " That Stones and Minerals, " formed of Cryſtal and Spar, need not be ſuppoſed all of them as " old as the Creation or Deluge; but may be, and unqueſtionably " are, formed to this Day."

Shape, and the ſmooth Sides which *Corniſh Diamonds* make in Incruſtations, and all after and ſecondary Concretions. This ſparry Liquor is ſtiff and ſluggiſh, and apt to harden; but it is a Liquor however, before it becomes a Stone. —— Nor is this Opinion ſingular, but adopted by many of the Moderns as well as Antients. *Pliny* (4), from the Reſemblance that Cryſtals have to Water, carried this Hypotheſis much too far, and thought them to be nothing more than Water congealed by exceſſive Cold; and *Diodorus* eſteems them no better than a Concretion of pure Water, aſſigning however a different Cauſe, concluding them harden'd by a divine Heat. *Agricola* makes the *Succus lapideſcens* the original Matter of which Stones are formed, ſome by the Heat, others by the Cold (5) they meet with, during the State of Fluidity (6). Mr. *Geoffroy*'s Hypotheſis ſuppoſes Cryſtal to be formed of thin equable Plates, that Water is the Vehicle of cryſtalline Parts; and when thoſe Parts meet together in any Quantities, the Water eaſily evaporating leaves the Cryſtals to form themſelves into hard, pellucid Bodies. Mr. *Boyle*'s Opinion was, that theſe Bodies were originally in a fluid State (7).

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(4) *Lib.* 37. *c.* 2.

(5) " *Utroque enim modo effici poteſt Lapis.*" *Ag. de Ort. Subt. Lib.* 4. *Baſil. Edit. p.* 57.

(6) *Ib. p.* 56.

(7) See *Boerhaave*'s Theory of Chemiſtry, by *Shaw*, *Not.* 120.

SECT.

SECT. 2.

Whence this Fluidity.

'Tis Water that firſt occaſions, and afterwards maintains, this Fluidity; and the Reaſon why we find none of this ſparry Maſs in its fluid State, nor ever ſee this lapideous Juice, is, becauſe that whilſt it remains incorporated with the Water, it is not to be diſtinguiſh'd from the Liquor in which it ſwims; and as ſoon as ever it is deſerted by the Water that circulated it in the Bowels of the Earth, and other neceſſary Circumſtances concur to produce that Change, it becomes Stone: By Water it is that the ſparry Atoms are waſhed forth out of their Repoſitories (8), collected into a thick, tranſparent, or opaque Juice (the ſtony Particles attracting each other as much as the intermediate Water will give leave); and as ſoon as the redundant Water is drained off, or evaporated, the lapideous Parts (now more at Liberty) accede to a cloſer Union, and are aſſiſted greatly therein, as well by the condenſing Nature of Cold, which compreſſes the Parts, and forces them nearer one to the other, as by ſudden evaporating Heats; and thus the Stone forms itſelf, ſo much Water reſting in the Pores and Interſtices of the Parts (in proportion to the Number and Magnitude of thoſe Pores), as is neceſſary to fix it into a Conſiſtency; for, as I apprehend, there is no compound Body, but by means of the Chemiſt's Fire will yield ſome Water; but as ſoon as all the Water is thrown off, the Body loſes its Hardneſs and Continuity, and turns to a Calx and Powder.

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(8) *Woodward's* Nat. Hiſt. of the Earth, 2d Edit. p. 189. "Water is the only Agent that educes the Matter, of which they "(*viz.* Spar and Cryſtal) conſiſt, out of the Strata, and compiles "and forms it in the perpendicular Fiſſures." *Woodward's N. Hiſt. of Foſſ.* Vol. 1. p. 150.

Here, Sir, I beg Leave to propoſe a few Queries to you.

1*ſt Query*, Whether Spar is not the univerſal Gluten of Stones, diſtinguiſhed from each other by the various Mixtures of earthy, mineral, or metallic Particles, but all united by the ſparry Liquor? Of this I ſhould be glad to have your Opinion; for it ſeems to me, that there is ſcarce any Sand, Nodule, Stone, or Ore, which either by the naked Eye, or Glaſſes, may not be diſcerned to have a certain Portion of Spar, clear, or opaque, in its Compoſition.

2*d Query*. Whether it is not reaſonable to believe, that Stones in all Ages have been, and are ſtill forming in the Earth, in ſome ſuch Manner as is here mentioned, whenever the neceſſary Materials and Cauſe concur with proper Incidents?

3*d Query*. Whether this Hypotheſis is not better adapted to account for teſtaceous, and other extraneous Bodies, found incloſed ſo often in Maſſes of Stone, than Dr. *Woodward's* Suppoſition, that all Stones were reduced into a fluid Maſs by the Waters of the Deluge; which Waters being thoſe of the Ocean, we cannot allow to have any ſuch diſſolving

Power inherent in them, and therefore they could produce no ſuch Effect?

4*th Query.* Whether there are not Quarries of Stone, which when left idle, or unwrought for ſome Time, yield a freſh Supply of Stone in the Chanels and Hollows of the ſaid Quarries, which had been before thoroughly cleared by the Workmen (9); and whether this will not confirm the Suppoſition, that Stones formed ſince the Deluge, in Places where Shells, Teeth, and the like Bodies, were depoſited by the Waters, incloſed them in their Subſtance?

You will excuſe this Digreſſion.

SECT. 3.

Different Appearances of Spar.

Our *Corniſh* Spars are either plain, ſimple, and unfigured, or figured into various and rectilineal Shapes.

All ſparry Liquor is in itſelf ſtiff and ſluggiſh, and covets no Shape; but, being intimately mixed with Water, which is the reſtleſs Agent, to diſperſe, collect, and renew all ſubterraneous Nature, it moves as a Fluidby the Rules of Gravitation, that is, from an higher to a lower Poſition, till meeting with a retentive Bed, the Water no ſooner retires, and leaves it expoſed to a drier or colder Air, than it dries, and hardens into Stone, in Shape and Size, as the Attraction and Quantity of its own Parts determine, or

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(9) See *Addiſon's* Travels into *Italy*, and Bp. *Burnet.*

the circumambient Bodies will give it Leave to fix and extend itſelf.

Plain Spars.

Sometimes we find the ſparry Liquor ſpread into thin Plates on the horizontal or oblique Planes of Rocks; ſometimes we trace it in Sheets down the Sides of Fiſſures; and where it meets with Impediments of Gravel, or Stone, it will reſemble branched Limbs, Clay, Boughs, and Stumps of Shrubs; ſometimes it drops from Vaults, and Roofs of Caves, whence it has the Name of *Stalactites* (10). In all theſe Caſes it is plain, that the Juice had no other Motion, whilſt a Juice, nor appears in any other Shape now a Stone, than what its own Weight or Gravitation, during its State of Fluidity, inclin'd it to. In theſe uninform'd rude Productions, it is very plain, I think, that the Juice wanted thoſe active Principles (whatever they be), which enable it at other Times to ſhoot into regular Forms.

Fig. 1. TAB. IV. (11). is a Spar Pebble, its Surface about the Roughneſs of the Peach-skin, incloſed in Part of its Socket, which is alſo of Spar, angular, and puculated (which latter Property is rarely met with): The Coat or Socket is mixed with ſolid white Mundic, and Cockle; which laſt (or the ſame Principle, which throws Cockle (12) into this oval Figure) ſeems to have determin'd this Spar to its ſingular, *viz.* orbicular Shape; for it is obſerved, that where Cockle is plenty, Spar-Nodules round as Musket Balls, and black, in Sockets of the ſame Colour and Subſtance, are frequently found.——But as this Pebble was not black, as Cockle always is; it may therefore be queſtioned, whether the Shape of it may not be owing to ſome metallic (*viz.* Iron or Copper) Principle, rather than to Cockle, and whether Cockle itſelf be not more probably indebted to other Powers for its orbicular Nodules, in ſuch Sheaths, than derive them from any inherent Activity of its own.—The Exterior of the Shell or Socket has a thin Incruſtation of gritty cinereous Mundic.---It came out of *Wheal Royal* Mine, in the Pariſh of *Cambron, Cornwall.*

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(10) It alſo veins or granulates, or both, every Kind of Stone; and is oftentimes found to compoſe whole Loads or Veins, without any metallic or mineral Mixture, or any particular Shape, more than the Fiſſure in which it reſted compreſſed it into.

(11) *N. B.* The following Figures, referred to, are intermixed in TABB. IV. and V.

Of Incruſtations.

The next Appearance of Spar Bodies, which I ſhall here take Notice of, is that of Incruſtations; theſe ſometimes make one continued Sheath, Lump, or Maſs, and incloſed in them we find *Corniſh Diamonds*, Grains of Tin, and other adventitious Bodies, plainly of a different Texture and Colour from the Cruſts which ſurround them; ſo that Incruſtations muſt be cautiouſly diſtinguiſhed from the entire Sheaths, or Laminæ, which compoſe the Column of hexagonal Cryſtals, and which are really form'd at the ſame time with that Column (13); whereas Incruſtations are additional, and after Concretions made on the before ſettled original Grains and Columns, (14) ſometimes theſe Incruſtations, are but Sprink-

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(12) Cockle is a black, ſhining, light Stone, free of all Metal, different from Mock-Lead, common in the Tin Mines of *Cornwall.*

(13) See p. 274. Note 26.

ings of the cryſtal Drops, without any Continuity, or mutual Contact; and in this Caſe, when the pearly Drops are themſelves bright and tranſparent, and the Stone they fix on, of an Agate Colour, or any lively Oppoſition, the Incruſtation is exceedingly beautiful. On one ſhotten bliſter'd Spar, I find the Incruſtation white, not pellucid, flowing in parallel Threads by each other (*Fig.* 2. TAB. V.), in ſeveral Places paſſing from one Tubercle to another, without touching the interſpers'd Hollows; by which I conclude, that this Spar was fixed on the perpendicular Side of a Fiſſure; that the Juice of this Incruſtation was of the *Stalactites* Kind, and, proceeding from the ſame Cauſe, deſcended in a ſimilar Direction.

Fig. 3. TAB. V. Is a Bunch of ſemi-pellucid Spar, ſhot into reclined Cones, making an Angle of 30 Degrees, with the Surface of the Stone; the Sides of theſe Cones are a very curious Fretwork of little Spires or Briſtles, many of them ſharp as the ſmalleſt Needle, and pointing nearly in the ſame Direction, as the Cone on which they riſe. The Surface of theſe Shoots is of a ferrugineous Tint, but their inner Subſtance pellucid, very little ſhort of that Spar, which for its Clearneſs is called Cryſtal, and

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(14) Incruſtations are ſo many evident Proofs of Stones not being formed all at the ſame Time; for many *Corniſh Diamonds*, and columnar Shoots of Tin, Cubes of Mundic, and Grains of Lead are often broke off from theſe their Incloſures; but the angular Cavities, with their ſtrait Edges and ſmooth Sides, ſtill appear in the Incruſtation; which plainly ſhews, that the Diamonds and Tin Shoots, *&c.* were firſt form'd and harden'd, and then ſurrounded and united into one Lump, by a ſucceſſive Induration of theſe Cryſtal or Spar Cruſts.

and more tranſparent than many hexagonal Shoots; 'tis the only one I have ſeen of its Kind.

Fig. 4. Tab. V. Is an Aſterisk of the cleareſt Spar; its Shoots or Rays are hexagonal, ſwelling, or gibbous, in the Middle; their Sides not plain, or of one level Surface, as our *Corniſh Diamonds* generally are, but ridg'd near the Edges, and ſomewhat hollow, but not uniformly, in the Middle; the Points or Terminations were entire and ſharp, but not to that Degree aculeated as the former conic Spar; but it is very plain, that theſe Spires never had any hexagonal Apices: The undermoſt Shoots ſpread horizontally; but the other riſe gradually, making a greater Angle, till the middle ones make nearly a right Angle with the Baſe, which has a ferrugineous circular Spot in the Middle, from whence the Rays regularly proceed on every Side. *Fig.* 5. Tab. V.

Theſe are ſome of the moſt ſingular Spars which have reach'd my Obſervation; but the general Shape of our figur'd Spars is hexagonal; and theſe Hexagons either conſiſt of a Shaft or Column, and a Point with the ſame Number of Sides correſpondent to the Column (*Fig.* 6. Tab. IV.) or are only Points, that is, pyramidal Hexagons ſtuck on at their Baſe, upon the Surface of their ſtony Beds. *Fig.* 7. Tab. IV.

In a thin Cake or Lump in my Poſſeſſion, one Half of the Spar ſhoots from one Side, the other Half from the other; and ſo incruſts the Planes of both Sides with hexagonal *Apices*. *Fig.* 8. Tab. IV.

Here the Spar (as appears by the Tendency of its Fibres, when the interior Texture is examin'd) ſtruggled to form Stems or Stalks to theſe *Cuſpides*; but either the Effort was not vigorous enough, or, through the Impurities of the Juice, the ſparry or cryſtalline Principles had no room to extend or protrude themſelves into the Shape they ſeem inclinable unto; ſo they lie blended, and their Lineaments ſcarcely to be diſtinguiſh'd from the general Maſs.

Some Spars riſe out of the general Surface, into large orbicular Bliſters, thick ſet with hexagonal Points diverging, as Rays from a Center. *Fig.* 9. TAB. IV.

Theſe Bliſters or Protuberances are in other Spars ſubdivided into Numbers of other ſmall, orbicular Excreſcencies, and the *Cuſpides* very ſmall, but, like the pointed Shoots of moſt *Corniſh* Spars, hexagonal. *Fig.* 10. TAB. IV.

At the Root, or where they join to the Rock, theſe globular Maſſes ſhew in what Direction the Juice exerted itſelf, ſpringing commonly, as from one general Center, and extending itſelf equably on every Side. When the Juice is ſimple, and of one Sort only, the Rays are continued from the Center to the Extremities; as *Fig.* 11. TAB. IV. But when the Juice is of two or more different Mixtures and Impregnations (which will generally appear from the different Colours and Degrees of Tranſparency), then the Effort is various and ſucceſſive, protruding the Juice according, and in proportion to the different Activity of the *Stamina*, of which it conſiſts; and in both theſe Caſes I find the coarſeſt and moſt terrene Part of the ſparry Lump next the Center, and the moſt tranſparent and pureſt ſhot forth, to form the pyramidal *Cuſpides* of the Circumference. Though the Effort is various and multiple, the ſeveral Juices preſerve a Paralleliſm to each other, and to the Extremity, each Juice proceeding no farther than its own Impregnation would carry it; and therefore ſettling in parallel Liſts or Lines behind each other, and their Angles leſs and leſs perfect, that is, becoming more obtuſe, till you come to the Rock, or lifeleſs Lump of Spar, which the Effort had no Power to move, and thro' which the impregnated and purer Juices eſcaped, according to their Degree of Mobility: The Baſe of one of theſe orbicular Lumps, which has ſeven diſtinct Liſts or Fillets one within the other, beſides leſſer Liſts, mark'd (*h*), will explain what is here ſuggeſted. *Fig.* 12. TAB. IV. ‡

Theſe hexagonal Points do not always ſit cloſe to the Body of the Rock, but are as often found mounted upon columnar Shoots of the ſame Number of Sides; and theſe are what are commonly called *Corniſh Diamonds*: They are generally found larger ſomewhat at the Baſe, where they faſten on the Rock, than at the Top, where they ſupport the *Cuſpis*. *Fig.* 13. TAB. IV.

Some of theſe Shoots have alſo hexagonal Points at each End, as *Fig.* 14. TAB. IV. and are ſometimes found ſingle, that is, detach'd, and without a Root, as the Naturaliſts ſay; but I have them alſo in Lumps fixed Side by Side, but in no parallel Direction. *Fig.* 15. TAB. IV. (15).

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‡ *a*. The cleareſt Cryſtal.
b. Sup-pellucid, inclining to purple.
c. Flock-white, not pellucid.
d. Large Fillet of purpled Spar.
e. Flock-white.
f. Small Fillet of purpled Spar.
g. Flock-white.
h. Liſts of Spar leſs diſtinct.
i. That Side on which the Effort was faint, and the Shoots ſcarce perceivable.

(15) Theſe Shoots are not always ſtrait, but are found ſometimes bent or crooked; but as this Deformity is owing to ſome accidental inter-

This is the general and moſt common Appearance of our *Corniſh* figur'd Spars and Cryſtals, *viz.* either hexagonal Points on the Rock, or common Spar, or fixed on Shoots or Columns of the ſame Figure; but we muſt not imagine, that Spar aſſumes no other Shape, but what has been here mentioned. There are alſo trigonal and cubical Spars; but of theſe Sorts I have not yet ſeen any in *Cornwall*; however, as our Obſervations in this inquiſitive Age are daily growing more extenſive, it is very probable, that new and undeſcribed Shapes of Spars may often fall under our Notice: What I have here mentioned ſeem moſt worth notice; but to pretend to number them all, would be very extravagant; for they are varying every Day upon our Hands, and new Mines throw forth new Forms, according to the different Combinations of their Solids, and the Impregnation of their Waters.

SECT. 4.

Whence the hexagonal Shape of Spars.

It has been obſerved before, (*p.* 257.) that Water and the ſparry Juice, conſidered ſimply, without any other Aid, will produce only the irregular, ſhapeleſs Maſſes of Spar, incapable of any Activity, or Struggle towards Shape and Figure, and determined only by the common Principle of Gravitation, to that Poſition in which we find it: We muſt call

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interpoſing Force or Obſtruction, during the Time of forcing, it will not, I apprehend, make the Body of a different Species, as long as all the other common Properties are continued.

call in therefore the Aſſiſtance of ſome other Principle, to account for the rectilineal regular Phænomena of theſe ſparry Productions.

As the general Appearance of our *Corniſh* Spars is hexagonal and uniform, there muſt be ſome one general Principle to which this great Uniformity is to be referred. If theſe Spars owed their Form to any metallic Principle, that Metal would be found, when the Fluor was thrown off by Fire: But the contrary is apparent, the cleareſt Spars yielding no Metal. And, indeed, it may here be obſerved, that when the ſtony Juice meets and coaleſces with any metallic Particles, that Juice ſhoots not into its natural Form, but by Tin is forced into Priſms, and various *Speculums*; by Lead, into Cubes; and by other Metals into other Forms: So that it never retains its hexagonal Shape, but when free of Metals. As therefore there is no Metal in our regularly-figur'd Spars, we muſt have recourſe to another Origination; and Salt, as I take it, is moſt likely to be that active Principle, by whoſe Force the Fluid in which it is mix'd, be it pure Water, or lapideous Juice, is made to ſhoot forth into regular rectilineal Maſſes, agreeable to the original Shape and Figuration in which theſe Salts were firſt created. 'Tis by the Force of Salts that liquid Bodies are thrown into all the geometrical Planes, Angles, and more compounded Shapes, the Variety of which is no leſs ſurpriſing, than the Conſtancy and Uniformity of each particular Species; the ſame Salt ſhooting ſtill into the ſame Figure (as is plain from all artificial Cryſtallizations), when not ſtreightened in Room, or otherwiſe determined by heterogeneous Mixtures. To produce Salt

from

from any liquid Body, two things are requiſite: Firſt, that the redundant Liquor, in which the ſaline Particles are kept too diſperſed and remote to attract each other, be diſcharged (which is uſually performed by Evaporation), and that the Remainder be expoſed to a colder Air. This ſimple plain Proceſs will produce all the Varieties of Cryſtallization; the Salts contained will ſhoot into their peculiar Forms, pointing forth their Darts, regular Planes, or Spires, into ſuch Figures as are proper either to their native or compounded Salts. From this eaſy and inconteſtable Procedure of Liquids into figur'd and ſolid Bodies (to which nothing more is required than Heat and Cold), may it not appear probable, that ſomething like this has happened, and does ſtill happen, among our Spar-Loads in the Mine? For Inſtance: When the Juice of Spar, impregnated ſtrongly with Salts, which have been from time to time imbibed, is ſufficiently drained from the Water (which not only collected the ſparry Maſs, but kept it in a fluid State), either by natural Heat, ſo common in Mines, or by the Water's running off into Crevices, where the ſtiffer Stone-juice cannot follow it; in other Words, when the Water deſerts the Spar; the Spar, as ſoon as a colder Air ſucceeds (16), ſhoots, and is protruded into Figures by the Salt which it contains (17); and thus

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(16) "*Cryſtallus eſt ſuccus, quem frigus intra terram conglutinavit.*" Agric. p. 282.

(17) Mr. *Boyle*'s Opinion is, that ſuch Stones (*viz.* Spars and Cryſtals) were originally in a fluid State; that the Figure of them is determinate and geometrical, like the Cryſtals produced by Alum, Nitre, Vitriol, in Water; and their Texture like the Congelations of Salt produced in Cryſtallization by Cold.

Grew

thus it happens that we have ſuch figur'd Bodies from the Spar, which, without thoſe Salts, would ſhew us no ſuch Shoots as we call *Corniſh* Diamonds, but fix quietly into Sheets, and even Plates, or drop down where-ever its own Weight would carry it.

What ſort of Salt it is, which inclines Spar to this hexagonal Form, is the next thing to be inquired into; and moſt probably will appear to be that of Nitre, if we conſider that the Reſemblance betwixt the Figure of what we call *Corniſh* Diamonds, and that of the pure unmix'd Nitre, is ſo great, that no two things can be more exactly alike. " The known Figure of " Nitre, ſays *Grew* (*Coſmol. p.* 15.) is a ſexangular " Priſm." " Particulas nitri *Liſterus* deprehendit " ſexangulas, tenues, longas, lateribus parallelo- " grammis, & ex altera parte in pyramidale acumen " deſinentes." *Phyſ. Cler.* 8*vo, tert. Edit. p.* 150. This exact Reſemblance is ſufficient to make us conjecture, that theſe ſparry Productions may owe their general Figure to a nitrous Salt, which exerted itſelf at the time when the Juice of Spar became Stone; and I ſhall endeavour to ſupport this Conjecture only by one Authority, which is that of the curious, and, in the Studies of Natural Hiſtory, indefatigable *Linnæus*, which he favoured me with in Anſwer to ſome Queries, jointly with the Opinion of the preſent Dr. *John Frederick Gronovius* of *Leyden*. " The Origine of " thoſe Cryſtals (18) is a moſt intricate thing; but " you may conclude----*quod omnis cryſtallizatio a*

Grew (*Coſmol. p.* 14.) after talking of the Regularity of Forms, and the Salts of Bodies, proceeds thus: " Arguing (ſays he) that the Atoms " of the lapidific, as well as of the ſaline Principle, being regular, do " therefore concur in producing regular Stones."

(18) *Corniſh* Diamonds, ſent to Dr. *Gronovius* from *Cornwall.*

“ *ſale, quod cryſtalli gaudent figura nitri, quodque*
“ *omnes generentur in cavo: Hi (viz. cryſtalli) quo*
“ *magis ſimplices, eo magis puri & pellucidi: Hinc*
“ *nitro originem debent, quemadmodum gemmæ iſtæ,*
“ *quæ priſmaticam nitri figuram exhibent.*”

As Nitre may be reaſonably conjectured to give the ordinary and general hexagonal Figure to Cryſtals, it may be as juſtly inferred, that when they depart from this Uniformity, it is owing to ſome mineral, earthy, or metallic Mixture, ſome heterogeneous Salt, which impedes the Nitre in its ſhooting, and turns it into trigonal, cubical, conic, or other unuſual Figures.

SECT. 5.

Of their SIZE.

The next thing to be conſidered, is the Cauſe to which the different Size in which theſe Bodies do appear may be owing, Some Cryſtals are ſaid to be a Cubit high: *Livia Auguſta* dedicated one in the *Capitol* of fifty Pounds Weight (19); and Dr. *Iſaac Lawſon*, late Phyſician to the Army in *Flanders*, informed me, that he ſaw a Cryſtal in a foreign Mine, with its Edges well preſerved, which he believed might weigh about 200 Pounds. Dr. *Woodward* reckons, among his *Corniſh* Diamonds, a ſingle Column or Shoot very large, if it be three Inches in Length, and one Inch and half in Diameter near the Baſe. The largeſt I have yet ſeen in *Cornwall* weighs ſomewhat more than three Pounds, is about ten Inches in Girt at the largeſt End, and more than ſeven high; from which Size there are of all Degrees, down to the Bigneſs of a ſmall Pin. As the Size of this laſt-mentioned is very unuſual, I have given a Drawing of it, *Fig.* 16. TAB. V.

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(19) *Pliny, lib.* 37. *c.* 2. Sir *Hans Sloane* has one Block of Cryſtal which weighs between 40 and 50 Pounds, and another about 20, quite clear and regular. *C. M.*

(20) *Catal.* 158. *f.* 98.

The largeſt proceed out of a large Courſe or Load of Spar; but the ſmalleſt of all from ſmall Bits or Lumps of Spar; and the ſmall pyramidal *Apices* are generally ſtuck on upon the Side of the large ones, ſometimes in diſtant Spangles, other times in thin and broken Incruſtations. Now the Cauſe of theſe different Sizes ſeems to be this: Where-ever great Maſſes of the ſparry Juice have happened at the ſame time to be in a State of Fluidity, the exuberant Water drained off ſuddenly, and conſequently left Cavity ſufficient for the Salts to extend themſelves, there the great Quantities of nitrous Salts mixed with the lapideous Juice incline it to ſhoot vigorouſly, and form large Cryſtallizations; and from proportionably leſſer Maſſes, whilſt they are indurating, proceed leſſer Diamonds. If the whole Maſs be impregnated with nitrous Salts, the whole Surface of the Rock ſhall riſe into Points or Spires (21), according as the Maſs is more free or more ſtubborn to comply with the Agitation. If the nitrous Salts are not intimately mixed, but ſwim in Clouds and Bunches, thoſe Lumps only, where the Nitre is, ſhall be ſhot, and the reſt be plain. This is the Caſe when the ſparry Juice gets into its proper *Nidus*, or reſts in its Fiſſure. But where ſmall ſcatter'd Quantities of this ſtony Juice circulate in the ſubterraneous Waters, ſome trickle down the Sides of Stones and Fiſſures, and already-formed Diamonds, and, ſticking in *little* Globules, form a Cruſt by Juxtapoſition, whoſe Points are ſexangular, their Columns ſhort, ſometimes crooked and unfiniſh'd. At other times Water, charged with theſe ſparry Juices, falling from higher into lower Parts of the Mine, cannot but be daſhed and diſperſed about the Cavity in all Directions; and thus it is, perhaps, that the diſtant Spangles, like the Dew or Miſt that riſes from a Caſcade ſprinkled on the Surfaces of all Bodies in their Reach, are there congealed, and ſhot by their Salts.

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(21) See *Fig.* 4. and *Fig.* 3. TAB. V. and *Fig.* 8. and 11. TAB. IV.

SECT. 6.

Of their COLOUR.

Spars are of different Colours, and different Degrees of Tranſparency; ſome yellow, ſome reddiſh, brown, green, purple, black, ſome of a cloudy fleecy white, ſome freckled with little Specks of various Colours and Magnitudes, and others of a Water not inferior to the pureſt Cryſtals. The Yellow is ſuppoſed to be indebted for its Tinge to Sulphur and Iron, or Lead, or both; the Red to Iron, and perhaps *Goſſan,* that general Companion of Copper; Green, to the Solutions or Ruſt of Copper; Copper will alſo probably impart its Purple (for of that Colour we find ſome of our moſt beautiful Copper Ores) to the Juices near it: Black may poſſibly be indebted to Copper alſo of like Colour, to Tin, or the Particles of Coal; but the moſt tranſparent owe that Advantage to the Purity and Simplicity of the Juices of which they are formed. What this Purity is owing to, cannot be ſo eaſily determined. Some think to Percolation, or ſtraining through the Pores of other Bodies, the lapideous Juice depoſiting the Sediment and Impurities, which it may have contracted in its Paſſage. Now, it is not impoſſible but that the Water, and that liquid Spar, of which theſe Bodies are principally formed, paſſing by their own Weight thro' a ſoft, porous, ſandy Stone in the *Oxford*, *Bath*, and other-like Quarries, may undergo a Change for the better, and acquire a greater Degree of Tranſparency; but it cannot be ſo with our Spar, on which we find the Cryſtals above-mentioned: For, beſides that theſe Cryſtals are found on both Sides the Stone (22) (which, in the Procedure of Percolation, could never happen), and in very large Shoots, our Spar will no more tranſpire or exude than Glaſs, it is of ſuch Conſiſtency and Hardneſs: So that whatever Filtration has happened to theſe Cryſtals, muſt have befallen them during a former Percolation, before they reſted in their preſent Beds, not from any ſweating thro' that Bed in which we find them, as Dr. *Plot* imagines (23).

Cryſtals therefore, it is certain, owe their Tranſparency and Purity to the ſimple State of the Juices that form them; but to what that State and Condition is owing is uncertain. Whether it may be to ſome purifying Menſtruum or Spirit, that precipitates every kind of Sediment, I do not preſume to ſay: I ſhall only obſerve, that in *Cornwall* the cleareſt Diamonds are for the moſt part found in a dry, lax, ſandy Soil, where no dirty or dark-colour'd Loam, Mineral, or opaque Stones prevail: So we may conclude in general, that if, during the Fluidity of theſe Bodies, no metallic or mineral Fume, no Duſt, Clay, or Sand, was imbibed, the Water and lapideous Juice make up a clear pellucid Maſs. If the Caſe was otherwiſe, whatever Impurities the Waters contracted, and had not at the time of forming diſcharged, are ſtill to be ſeen in the Stone.

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(22) See *Fig.* 8. Tab. IV.

(23) *Oxfordſh.* p. 98. and *Ramundus in Alonzo Barba*, p. 36.

SECT. 7.

Of their HARDNESS.

As to the Hardneſs of our *Corniſh* Cryſtals, all I have to obſerve is, that they cut well into Seals, when they have no Flaws: Their natural Points alſo will cut Glaſs; but not freely or deep; in which Particular they fall much ſhort of the true Diamond.

Conjectures relating to the Properties of the true Diamond.

Of this I ſhall not pretend to aſſign any other Reaſon, than that the true Diamond ſeems to have more lapideous Juice included, and more intimately and congenially united under an equal Surface, than any other Body in the World. It has alſo very little Salt in it, as Dr. *Grew* obſerves (*Coſmol. p.* 14.); and his Opinion is confirmed by its being found in ſuch ſmall Maſſes; and by its great Weight it can have little Water; both which Obſervations are ſupported by its great Reſiſtance, and almoſt Immutability in Fire: So that the true Diamond has little Salt, and little Water, conſiſting almoſt intirely of ſtony Juice concreted;

creted; to which Properties its great Hardneſs may therefore be attributed: Whereas in our Diamonds there is much Salt, and much Water (comparatively ſpeaking); which two Ingredients, mix'd with the lapideous Juice, may incline thoſe Bodies to be more friable and tender, and deprive them of that Hardneſs, which a leſs-reduced lapidific Juice would certainly have had. This ſems to me the real Cauſe of the true Diamond's Hardneſs, and of our falſe ones falling as much ſhort of it in this Particular, as in Luſtre: But I muſt acknowlege, that, for want of ſufficient Experiments relating to both, I cannot decide peremptorily. However, by weighing the *Corniſh* Diamonds in Water, I find they are generally to the Weight of our common Watter, at a Medium, as $10\frac{1}{2}$ is to 4; and I apprehend, that if they had more lapideous Particles, they would weigh more, as they find the true Diamond really does *. I find alſo the cleareſt and brighteſt *Corniſh* Diamonds weigh much heavier than the other which are more ſhady and opaque. That they have much Salt alſo, may be concluded from their being projected ſometimes into ſuch large, regular, hexagonal Columns.

SECT. 8.

Of the TEXTURE *of* Corniſh Diamonds.

There are ſome little Varieties in the Texture of our *Corniſh* Diamonds, which are ſometimes to be obſerved in their broken Sides and Edges; but always, and more diſtinctly, in their Baſe. Some are uniform, of one Colour and Tranſparency throughout;

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* The Weight of *Cryſtals* to Water is as $2\frac{1}{2}$ to 1. of *Diamonds* as $3\frac{1}{2}$ to 1. See theſe Tranſactions, No. 488. p. 451. *C. M.*

ſome have hexagonal Sheaths deſcribed one within another, as in *Fig*. 17. TAB. V. In the firſt Caſe, the ſhotten Juice was of one and the ſame Nature and Conſiſtency, equally impregnated, and the Production of one Effort; in the latter Caſe, where the Sheaths are one within another, 'tis alſo the Product of one Effort or Shoot, the Concretion of one and the ſame time, as the tremulous Undulations upon the Surface of Water, on throwing in a Stone, are all the Offspring of one Force, tho' the firſt be ſtrongeſt, and the reſt gradually fainter and leſs diſtinct: But the Juices being differently mix'd, gave way to the Effort in proportion to their Senſibility of the Impregnation, the moſt agile flying off to the greateſt Diſtance from the Center, and the moſt mix'd, coarſeſt, and moſt opaque, remaining neareſt the Center (24). That this is he true Proceſs, and that thoſe different Sheaths are the Produce of one Effort or Birth, and not formed at different times, and in Succeſſion, as *Steno* and *Aldrovandus*, and ſome others, ſay (25), is plain, I think, from the two following Obſervations (26). If the Juice which forms theſe Sheaths was impregnated and ſhot at different times, it would not form in Sheaths round what appears to be the Central or Maſter-ſhoot, but would project itſelf into its natural hexaedral Figure. If it were not impregnated, but mere Spar only, without Nitre, or any other active Principle, it would form itſelf, as the Stalactites, in a pendulous undulating Direction, Drop or Wave upon Wave; and in this Caſe theſe Sheaths could never ſurround, in that neat and exact manner, the central Shoot;

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(24) See *Fig*. 12. TAB. IV. and its Deſcription, *p*. 263.
(25) See *Plot's Oxf*. p. 98. (26) See p. 259. Note (13)

but would be found only on the under Part of that Shoot, where its own Gravity would inevitably carry it: For it would be obſerved immediately, that theſe Diamonds in the Mine point forth in all Directions; which muſt conſequently prevent every unimpregnated Juice from hardening into a regular uniform Sheath.

It is alſo to be noted, that theſe Sheaths are often found broke and interrupted: But this cannot be owing to their being *Gemmæ inchoatæ & non perfectæ* (27), for the above-mentioned Reaſons, but to the Inſufficiency and Want of Juice, or to ſome accidental Impediments of Stone, Earth, or Sand, which make thoſe Breaks, and prevent it from forming a complete Sheath.

SECT. 9.

Of their DIRECTION *in the* Mine.

Not long ſince I went with a Friend or two into a Mine called *Pillion Erth*, in the Pariſh of *St. Juſt*, on purpoſe to ſurvey the *Corniſh* Cryſtals in their natural Situation. The Cave, to which we were introduced, was not much larger than a common Baker's Oven, and much of that Figure. We had two Candles with us, by means of which we ſaw the Roof, which might, in the Middle, be about five Feet high from the Floor; in the other Parts not ſo much. The Roof was the moſt ſurpriſing Piece of Fretwork imaginable, and conſiſted intirely of Spar ſhot into *Corniſh* Diamonds, of which the large one (*Fig.* 16. TAB. V.) was a Part. I could not diſcern any coveting a Poſition

exactly

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(27) As *Plot, ibid. ut ſupra.*

exactly perpendicular to the Horizon; but in every indifferent Direction they pointed forth very plentifully of ſeveral Sizes; ſometimes in Groupes and Cluſters, ſometimes ſingle, now croſſing each other, and now ſtanding by each other with parallel Sides: Some were ſmooth, ſhining, and clear, others rough and opaque; ſome vein'd with red, like Porphyry; others ſpeckled thick with the ſmalleſt Spots of deep Purple, and a bluiſh Caſt: But the fineſt of all were thoſe which had innumerable little Diamonds or Sparks (of the cleareſt Water) ſtuck upon their Sides, and, by means of the Candle, had a Luſtre not to be conceived. We gazed here in this incommodious, but beautiful little Cave, till we could no longer hold up our Heads; and then crept out as we came in, upon our Knees.

Now, among the great Numbers of ſparry Productions which I ſaw in this Mine, I could not obſerve, but that they pointed indifferently in all manner of Directions; which I ſuppoſe owing to the great Unevenneſs of the Surface on which the Baſes of theſe little Columns were fix'd; and for the ſame Reaſon I doubt not, but in all concave Beds the Points converge, as in all convex they turn the contrary Way, and diverge, as from a Center: So that the natural Cauſe of theſe different Directions is probably no other than the accidental Form of that general Maſs from whence theſe Shoots proceed. I would ſay, that as the Figure and Regularity of the lapidific impregnated Matter happens to be when drained of all ſuperfluous Moiſture, and by the Cold, Heat, or Dryth, diſpoſed to ſhoot, ſo will the Tendency of the Shoots, both Column and Point, be. If the concave Part (for Inſtance) of the *Voluta* of the *Cornu-ammonis* be ſet with Cryſtals, their Points muſt tend inwards to the Center, where the Tail ends, being thereto compelled by the regular Contour of the Shell; and indeed they are ſo in Fact, as ſee *Fig.* 18. TAB. V. But if the Cryſtal Juice chance to fix on, or proceed from a convex Bed (to which its *Nidus*, and other Cauſes, may contribute), or be itſelf an orbicular Lump, and equally impregnated on all Sides; then will the Fibres ſpring as from one common Center, and at their Extremities point forth their *Cuſpides* in a circular Figure, as in *Fig.* 19.* TAB. V.

If there be a thin Plate of Spar equally expoſed to Cold on each Side, and having equal Room and Force to ſhoot, it will throw forth its Points on each Side; and the Line from whence the Fibres began to ſpring ſhall be exactly in the Middle of ſuch Plate of Spar, and the Figures ſhall cut the ſaid Line at right Angles, as in *Fig.* 8. TAB. IV. whence it ſeems reaſonable to conclude, that the Direction in which theſe ſparry Productions ſhoot forth is generally rectangular, or very near it, to the Beds or Maſſes from which they proceed; and that all the ſeeming Confuſion in Pointings of the *Corniſh* Diamonds in *Pillion Erth*, was owing to the great Variety of Planes and Surfaces, into which that large Body of Spar was hardening, when theſe Diamonds ſhot from its Extremities.

I am, Sir,

Ludgvan, Oct. 18.
1749.

Your moſt obedient Servant,

WM. BORLASE.

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* See *Fig.* 5. *p.* 261.

XV.

Fig. 11. p. 262.

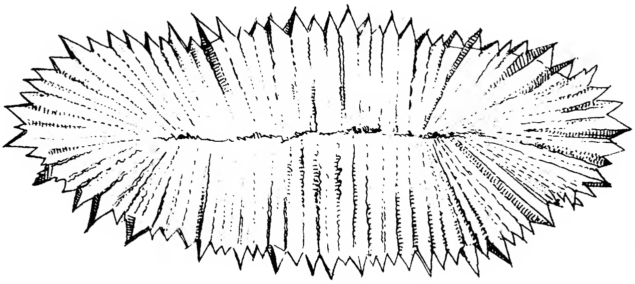


Fig. 1. p. 258.

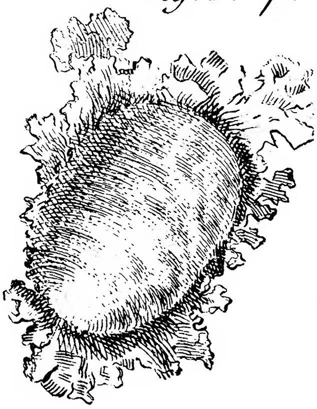


Fig. 12. p. 263.

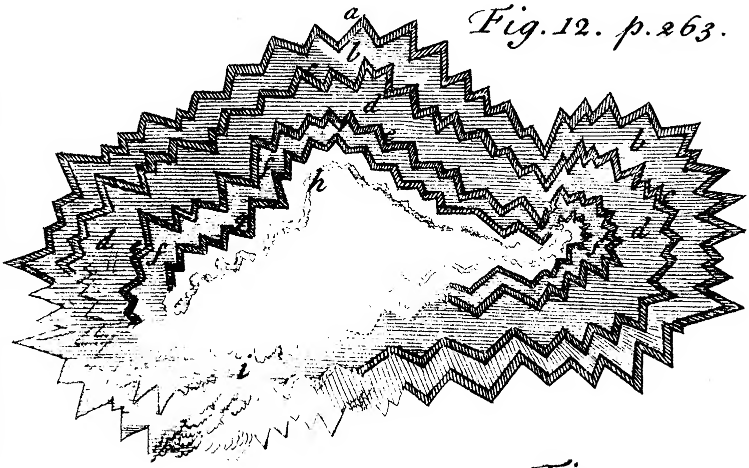


Fig. 6. p. 261.

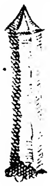
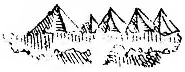
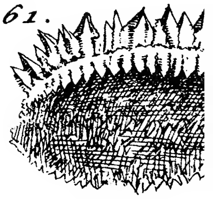


Fig. 7. p. 261.





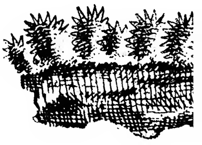


Fig. 14. p. 263.

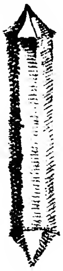


Fig. 13. p. 263.

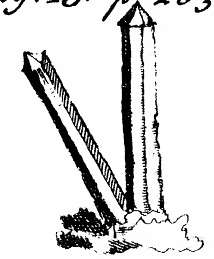
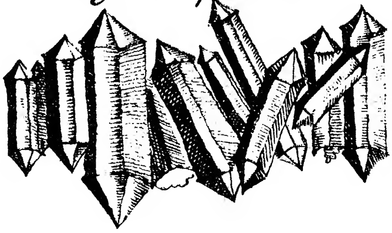


Fig. 15. p. 263.



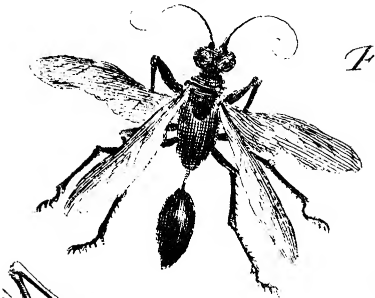


Fig. 20. p. 278.

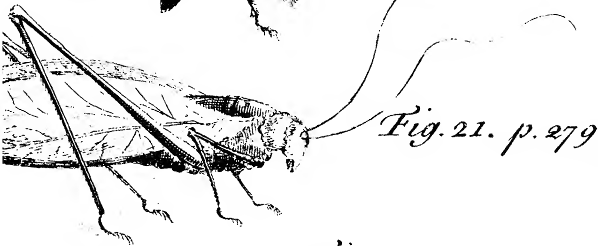


Fig. 21. p. 279.

Fig. 8. p. 261. 271.

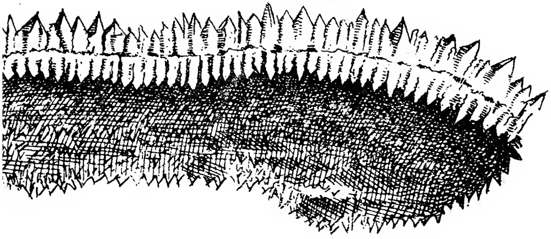


Fig. 9. p. 262.

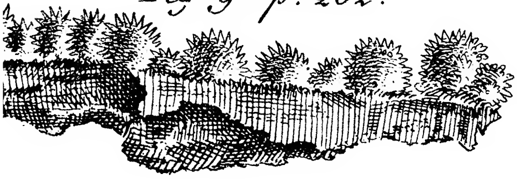
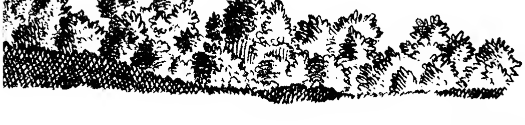


Fig. 10. p. 262.



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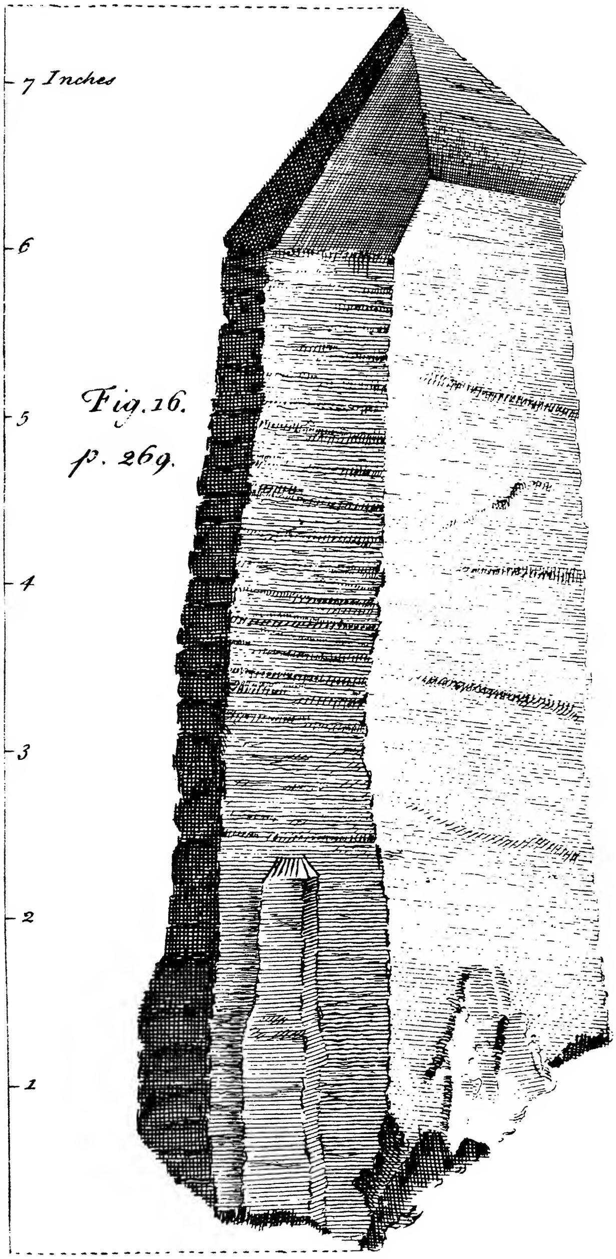
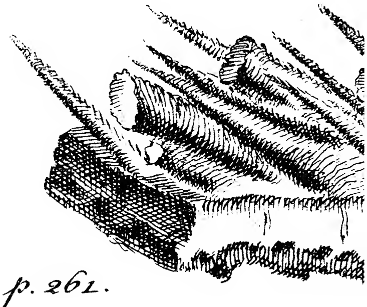


Fig. 16.
p. 269.



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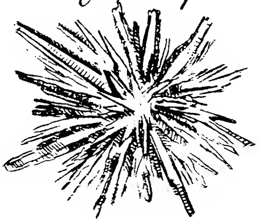
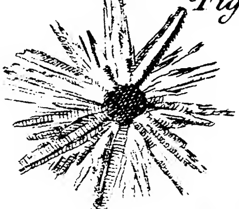


Fig. 5. & y^e Base of Fig. 4.
p. 261.



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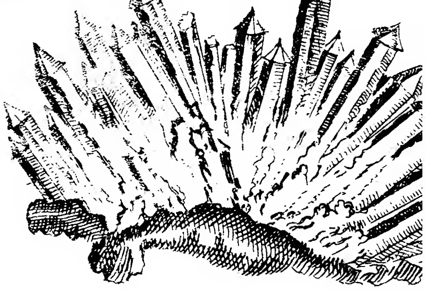
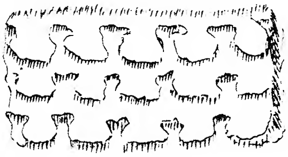


Fig. 22. p. 252.



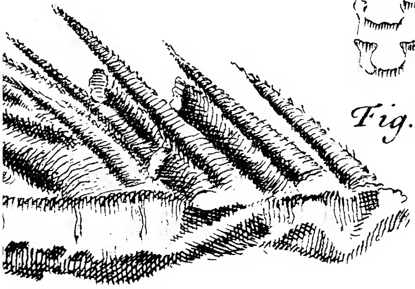


Fig. 3.
p. 260.

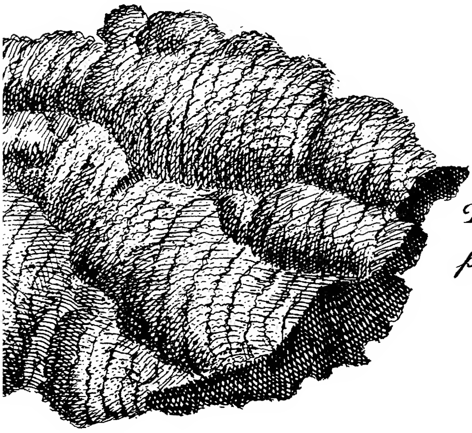
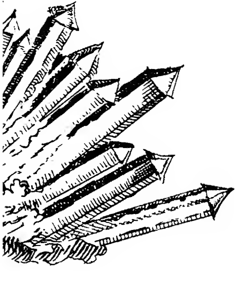


Fig. 2.
p. 260.

277.



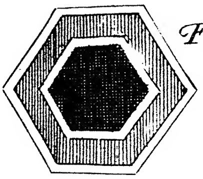


Fig. 17.
p. 274.

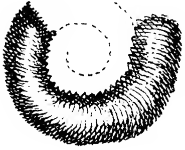


Fig. 18.
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Fig 11 p 262

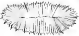

Fig 1 p 258

Fig 20 p 278

Fig 22 p 279

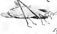

Fig 12 p 263

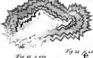

Fig 6 p 262

Fig 7 p 262

Fig 8 p 262 271

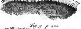

Fig 9 p 262

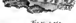

Fig 15 p 263

Fig 13 p 263

Fig 14 p 263

Fig 10 p 262

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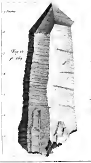
7 Inches
Fig 16
p 269

Fig 22 p 252

Fig 3
p 260

Fig 4 p 262

Fig 2
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Fig 5 & 9 Base of
Fig 4
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Fig 19 p 2

Fig 17
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Fig 18
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